CONVERSION OF TWO LIGNOCELLULOSIC AGRO-WASTES INTO VALUABLE PRODUCTS

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There are huge quantities of lignocellulosic agro-wastes available worldwide. These materials are renewable resources rich in major biopolymers like cellulose (30- 50%), hemicelluloses (20-50%, and lignins (15-35%). The aim of this project is to explore the conversion of xylan from two lignocellulosic wastes (rice and wheat), through acid hydrolysis, into xylose and then to xylitol. Xylitol is an FDA approved food additive used as sweetener and antibacterial agent. The solid residue remaining after xylan removal will then be converted by catalytic organosolv pulping into cellulosic pulp and organosolv lignin. The obtained biopolymers will be compared to those directly obtained from rice husk and wheat straw by the same catalytic organosolv pulping in order to evaluate the effect of xylan removal and conversion on the properties of these biopolymers. The structural properties of the isolated lignins will be studied by 1D and 2D NMR, as well as by thermal analyses (TGA and DTA). The polymer properties of lignin will be studied by GPC to evaluate how the pre-hydrolysis applied to remove xylan affected their structures. The cellulosic pulp will be evaluated for its content of residual lignin and for its polymer properties. The results of these analyses will determine the further application of these biopolymers in composite materials or, in the case of lignins, as sources of antioxidant and flavor molecules, such as vanillin, through chemical or microbial conversion. The use of agro-wastes for the production of food additives and biopolymers for materials development and conversion into antioxidants proposed in our project represents a paradigm shift towards sustainable development in the agricultural sector, through a collaboration with a forestry department.

Biotechnological production of xylitol from agro-wastes (rice husk and wheat straw) represents the most cost effective alternative for its synthesis at the industrial level, usually performed by chemical reduction of xylose. In this project, the conversion of xylose into xylitol will be performed in collaboration with the Indian partner using a relevant microbial strain. In this research project, a sequence of hydrolysis and microbial biotransformation process is followed by subsequent transformation of solid residue through a patented catalytic organosolv process into biopolymers: cellulose and lignin. The approach adopted in this research project represents a biorefinery concept adapted to lignocellulosic agro-waste. It is applied in a similar fashion as it is commonly practiced with forest residues, thus showing the complementarity of the agricultural and forest sectors.

OPTIMISATION DE L'HYDROLYSE ACIDE SUR DEUX AGRO-DÉCHETS : BALLES DE RIZ ET PAILLES DE BLÉ

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La production des céréales dans l'industrie agroalimentaire engendre une grande quantité de déchets lignocellulosiques, comme les balles (écales) et les pailles. Ils sont souvent utilisés comme litière, comme engrais ou encore comme combustible. Cependant, ils pourraient être considérés de meilleures façons que simplement comme de simples déchets agricoles. Pour les valoriser, il est nécessaire d'évaluer leur potentiel en analysant leur composition chimique. Ainsi, les taux d'extractibles de cellulose, de lignines, de pentosanes et des cendres ont été calculés à partir des différentes méthodes de quantification élaborées dans les laboratoires du CRMR. Une partie importante de ce projet international consiste à convertir les xylanes en xylose par hydrolyse acide, tout en évitant une trop grande conversion du xylose en furfural ou 5-hydroxyméthylfurfural. L'objectif principal étant la conversion microbiologique du xylose en xylitol, il est primordial de préserver le taux maximal du xylose. Ainsi, les différents taux de xylose, de furfural et de 5-hydroxyméthylfurfural ont été mesurés par HPLC. À partir de ces résultats préliminaires, les conditions optimales de l'hydrolyse sont déterminées.